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THE RELATIONSHIP BETWEEN POSTURAL AND NUTRITIONAL STATUS IN PRESCHOOL CHILDREN

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Abstract: The aim of the research is to determine the postural status, nutritional status, and their interrelationship, as well as to identify differences in relation to gender dimorphism. The research methods used in this study are observational and descriptive with a cross-sectional design. Data were collected from a sample of 177 participants from the preschool institutions in the city of Bijeljina. The study included 92 female partici-pants and 85 male participants, aged six years (6±0.5). The postural status was asse-ssed using the Napoleon Wolanski method and nutritional status using stan-dardized calibrated instruments that served to calculate the BMI. To determine the relationship between nutritional and postural status, the Spearman correlation coe-fficient was used, while the chi-square test was applied to determine differences in postural status with regard to gender dimorphism. The study found no significant relationship between nutritional and postural status in preschoolage children, regardless of gender dimorphism. However, it revealed a high prevalence of postural disorders and overweight among the children. Participating in appropriate and organized physical activity during preschool and leisure time is crucial for children's health, requiring consistent observation and evaluation of relevant factors.

Keywords: postural disorders, nutritional status, preschool children, gender dimorphism

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Introduction

It is evident that with the increase in standards and technological achievements, there has been a decline in physical activity among contemporary individuals from birth to old age. Decreased physical activity in children is primarily attributed to: television, computers, transportation, elevators in buildings, etc. We can observe that children are increasingly engaging in less play and physical activities in the form of sports games, while spending more time in a sedentary position, sitting or lying down (Simov et al., 2011). Furthermore, the inactivity of parents and lack of interest in sports and physical activity also have a significant impact on the reduction of locomotion (Strojek et al., 2014).

Poor body posture in preschool and school-age children is an indicator of health issues that can become very serious if not corrected in a timely manner (Džibrić, 2019). Despite this, it often happens that such problems are not detected on time. Therefore, it can be said that educators themselves play a significant role in proper growth and development. Ideally, if educators could recognize the first signs of poor body posture (Brower & Nash, 1979), the prevention of postural disorders would be greatly facilitated. By systematically monitoring and assessing the postural status of children, many health problems can be identified in a timely manner - before they become serious.

The muscles play the most significant role in shaping and maintaining proper body posture, as an active part of the locomotor system. Weakness in specific muscle groups, excessive or unilateral loading, can lead to various disorders in the spine, chest, upper or lower extremities, particularly in the foot. Due to the plasticity and sensitivity of the child's body, the formation of proper postural status is of particular importance during the preschool period of development and in the early years of schooling (Sabo, 2006b).

Considering the significant importance of postural status for human health and the normal functioning of the entire body, exceptional attention should be devoted to this issue. The modern way of life, particularly hypokinesia, poses a real threat to maintaining a normal upright posture. A sedentary lifestyle has a particularly negative impact during the sensitive period of development, specifically the preschool age (Sabo, 2008).

A disorder in postural status is frequently the result of improper foot and leg positioning. The shape of the legs, particularly flat feet, often leads to disorder in the posture of other body parts, especially the spinal column, resulting in back pain. In later stages, this can cause impairments in work capacity and disruptions in the functioning of specific organs.

Overweight and obesity

Obesity is commonly defined as a pathological accumulation of adipose tissue in the body (Wabitsch, 2000), which is most commonly expressed through the body mass index (BMI). Obesity represents a chronic non-communicable disease that arises as a result of multiple factors. There is no complete consensus on the exact causes of this condition. It is believed to arise from the integration of social, behavioral, cultural, physiological, metabolic, and genetic factors (Đokić & Međedović, 2013).

Excessive weight and obesity are responsible for approximately 80% of type 2 diabetes cases, 35% of myocardial infarctions, and 55% of high blood pressure diseases among adults in Europe, leading to over a million annual deaths (Kisić-Tepavčević et al., 2008; Tsigos et al., 2008; Vuković et al., 2012). The association between obesity and these diseases at such an early age contributes to a shortened life expectancy, adding a significant burden of illness in adulthood (Freedman et al., 2001).

Alongside genetic predisposition and other biological factors such as birth weight and intrauterine development, socio-economic status and family living conditions (smoking, alcohol intake, breastfeeding, parental nutritional status, parental education level, living space, and dietary habits) (Nikolić et al., 2023) are considered to play a fundamental role in the development of obesity among children together with the child's behavior (Burke, 2006). Lack of physical activity and excessive food intake are dominant factors contributing to obesity and the occurrence of postural disorders. Physical inactivity leads to muscular hypotrophy and decreased muscle tone, which, combined with improper posture while sitting and walking, contributes to the development of postural disorders.

Postural status

Proper body posture is a state of good musculoskeletal balance that protects against the occurrence and progressive development of postural disorders in the structures responsible for maintaining the body in an upright or other position, whether in motion or at rest (Protić-Gava & Šćepanović, 2012). The concept of proper posture refers to an upright, effortless standing position in which the physiological curves of the spinal column remain within normal ranges (Živković, 2000). In the cervical region of the spinal column, there is a physiological lordosis - a convex curve forward, in the thoracic region, a physiological kyphosis - a convex curve backward, and in the lumbar region, a physiological lordosis is formed with a convex curve forward.

According to Bogdanović and Milenković (2008), poor body posture encompasses any deviation of the physiological curves of the spinal column or feet from the norm, characterized by muscle weakness.

The subject of this study is the postural and nutritional status of preschool children, aiming to determine their nutrition, postural status, their relationship, and potential differences with respect to gender dimorphism.

Method

The research method used in this study involved both exploratory and descriptive approaches with a cross-sectional time determination.

To determine the relationship between the nutrition and postural status of preschool children, data was collected from a sample of 177 participants from preschool institutions in "Čika Jova Zmaj" kindergartens in the city of Bijeljina. The study included 92 female and 85 male participants, all six years old (6±0.5).

Postural status was assessed using Napoleon Volansky's method. Body segments were analyzed in the following order: head posture, shoulder posture, chest development, scapular posture, deviation of the spinal column in the frontal plane, abdominal posture, leg shape, and foot arches (Sabo, 2006a).

According to Napoleon Volansky, a three-step scale with scores of 0, 1, and 2 is used to assess postural status. A score of 0 is given when all parameters are within normal range, indicating a normal status. Score 1 represents a certain deviation from the normal body posture. Score 2 is characterized by significant deviations from the normal status.

To determine longitudinal dimensionality - body height, the anthropometer by Martin was used. Medical scales were used to determine body mass. The instruments used were of standard make and calibrated before the measurements. Body mass index (BMI) was calculated using the formula BMI=kg/m2 = weight (kg) / height (m)2, and the classification of participants was based on accepted values for overweight and obesity in children and adolescents (Cole et al., 2000). When values are equal to or above the 95th percentile for children of the same age and sex, the child is considered obese, while overweight is defined by values falling within the range of the 85th to 95th percentile (Barlow & the Expert Committee, 2007).

All participants, including their parents and caregivers, were thoroughly informed orally and in writing about the testing procedure, its purpose, and implementation. The measurements were conducted by a certified professor of physical education and sports in the kindergarten premises. During the measurements and assessment, the participants were barefoot and in lightweight clothing. The analysis of postural status for each participant was performed at a distance of 2m, with individual body segments being measured and assessed according to a pre-established order. Body height and weight were measured after the assessment of postural status. The collected data were entered into measurement sheets and then processed using data analysis software.

Head posture assessment is determined by its position in relation to an imaginary plane tangential to the upper part of the chest bone (Protić-Gava & Šćepanović, 2012). Head posture was observed in the sagittal plane. Shoulder posture was determined by projecting the tip of the shoulder in the sagittal plane relative to the neck. Shoulders were observed in the sagittal plane. Scapular posture refers to the evaluation of scapular alignment with the chest, specifically their fitting into a unified surface of the shoulders. Scapulae were observed in the frontal plane, from the back view. Chest development was assessed in the sagittal plane, with emphasis on its shape (development). Deviation of the spinal column in the frontal plane was evaluated by observing and assessing lateral deviations of the spinal column. Abdominal posture was observed in the sagittal plane, relative to the chest. Leg shape was observed from the front, and an appropriate rating ("X" or "O" legs) was given depending on the degree of deviation. Foot arch was assessed while standing on one foot, and the evaluation focused on the inner arch of the foot.

The obtained data belong to nonparametric ones and are obtained through the assessment of nutritional and postural status. All participants were initially divided into four categories based on their nutritional status (undernutrition - score 1, normal nutrition - score 2, excessive nutrition - score 3, obesity - score 4). The second division was based on the body posture score according to Napoleon Volanski (Table 1). Based on these two divisions, nonparametric results were obtained and subsequently analyzed. Spearman's correlation coefficient was applied to determine the relationship between nutritional status and postural status, and the $\chi 2$ test was used to establish differences in postural status with respect to gender dimorphism. The level of statistical significance for all statistical analyses was set at $p \leq 0.05$. The data were processed using the statistical software "IBM - SPSS 26.0".

Table 1. Definition of Scores and Grades of Postural Status according to Napoleon Volanski

SCORE	GRADE	DESCRIPTION
0	5	Excellent body posture
1-4	4	Very good body posture
5-8	3	Good body posture
9-12	2	Bad body posture
13-16	1	Very bad body posture

Results

In the total sample of 177 participants, presented in Table 2, the research results indicate that 38.4% of children were normal weight, 31% of children were under-weight, while one-third of children (30.6%) had an issue of overweight and obesity.

Table 2. Numerical and Percentage Representation of Nutritional Status in the Total Sample of Participants

NUTRITION LEVEL	N	%
Underweight – score 1	55	31.0%
Normal weight – score 2	68	38.4%
Overweight – score 3	21	11.9%
Obesity – score 4	33	18.7%
Total	**177**	**100%**

Table 3 presents the nutrition level among participants in relation to gender. Based on the results, it can be concluded that boys are either underweight or normal weight, while a larger number of girls experience issues with overweight and obesity.

Table 3. Numerical and Percentage Representation of Nutritional Status in Relation to Gender

NUTRITION LEVEL		BOYS	GIRLS	TOTAL
Underweight – score 1	N	31	24	55
	%	17.5%	13.5%	31.0%
Normal weight – score 2	N	32	36	68
	%	18.1%	20.3%	38.4%
Overweight – score 3	N	8	13	21
	%	4.6%	7.3%	11.9%
Obesity – score 4	N	14	19	33
	%	7.8%	10.9%	18.7%
Total	**N**	**85**	**92**	**177**
	%	**48.0%**	**52.0%**	**100%**

Table 4 displays the assessment of postural status among the entire sample, from which it can be concluded that a very small percentage of children have no deformities (1.8%), 65% have very good posture, and 33.2% of children have good body posture.

Table 4. Numerical and Percentage Representation of Postural Status in the Total Sample of Participants according to Napoleon Volanski

POSTURAL STATUS	N	%
Excellent posture – grade 5	3	1.8%
Very good posture – grade 4	115	65.0%
Good posture – grade 3	59	33.2%
Bad posture – grade 2	0	0.0%
Very bad posture – grade 1	0	0.0%
Total	**177**	**100%**

Based on the results from Table 5, the assessment of postural status in relation to gender indicates that girls have better posture compared to boys.

Table 5. Numerical and Percentage Representation of Postural Status in the Total Sample of Participants by Gender

POSTURAL STATUS		BOYS	GIRLS	TOTAL
Excellent posture – grade 5	N	1	2	3
	%	0.6%	1.2%	1.8%
Very good posture – grade 4	N	51	64	115
	%	28.8%	36.2%	65.0%
Good posture – grade 3	N	33	26	59
	%	18.6%	14.6%	33.2%
Bad posture – grade 2	N	0	0	0
	%	0.0%	0.0%	0.0%
Very bad posture – grade 1	N	0	0	0
	%	0.0%	0.0%	0.0%
Total	**N**	**85**	**92**	**100**
	%	**48.0%**	**52.0%**	**100%**

After establishing the association between the nutrition and postural status in preschool-aged children (Table 6), it can be stated that there is no statistically significant correlation between the nutrition and postural status in preschool-aged children (r=0.115).

Individually, a statistically significant correlation was found only between the nutrition and the foot arch (r=0.036). Other segments of postural status did not show a statistically significant correlation with the nutrition.

Table 6. Association between the Nutrition and Postural Status

POSTURAL STATUS	NUTRITION LEVEL	
	r	p
Overall postural status score	.091	.115
Head posture	.158	.056
Shoulder posture	.066	.382
Chest posture	-.007	.929
Shoulder blades posture	-.093	.221
Spine posture	-.123	.104
Stomach posture	.068	.367
Leg posture	.089	.238
Feet posture	.158	**.036***

The data in Table 7 shows that out of the total number of children, 79.1% have good head posture (grade 0), with 37.3% being boys and 41.8% being girls. 20.9% of children exhibit deviations from normal head posture (grade 1). None of the participants show a higher deviation from normal head posture (grade 2).

The analysis of the significance of differences indicates that there is no statistically significant difference in head posture between genders ($\chi 2 = 0.208$, $p = 0.649$).

Table 7. Numerical and Percentage Results of Head Posture Analysis by Gender

HEAD POSTURE		BOYS	GIRLS	TOTAL
0 = no deviation	N	66	74	140
	%	37.3%	41.8%	79.1%
1 = partial deviation	N	19	18	37
	%	10.7%	10.2%	20.9%
2 = extreme deviation	N	0	0	0
	%	0.0%	0.0%	0.0%
Total	**N**	**85**	**92**	**177**
	%	**48.0%**	**52.0%**	**100%**
χ^2***= 0.208 p= 0.649***				

Although there is no statistically significant difference (p=0.083) in shoulder posture among the participants based on gender, it can be observed that girls have better posture (Table 8). Grade 0 is assigned to 25.4% of boys and 35.6% of girls. Less deviation from normal shoulder posture is observed in 20.9% of boys and 15.8% of girls, while significant deviations from normal posture (structural changes) are present in 2.3% of children.

Table 8. Numerical and Percentage Results of Shoulder Posture Analysis by Gender

SHOULDER POSTURE		BOYS	GIRLS	TOTAL
0 = no deviation	N	45	63	108
	%	25.4%	35.6%	61%
1 = partial deviation	N	37	28	65
	%	20.9%	15.8%	36.7%
2 = extreme deviation	N	3	1	4
	%	1.7%	0.6%	2.3%
Total	**N**	**85**	**92**	**177**
	%	**48.0%**	**52.0%**	**100%**
χ^2***= 4.977 p= 0.083***				

There is no statistically significant difference in chest posture between genders (p=0.730).

Table 9. Numerical and percentage results of chest posture analysis by gender.

CHEST POSTURE		BOYS	GIRLS	TOTAL
0 = no deviation	N	52	60	112
	%	29.4%	33.9%	63.3%
1 = partial deviation	N	31	31	62
	%	17.5%	17.5%	35%
2 = extreme deviation	N	2	1	3
	%	1.1%	0.6%	1.7%
Total	**N**	**85**	**92**	**177**
	%	**48.0%**	**52.0%**	**100%**
χ^2= 0.629 p= 0.730				

Based on the results in Table 10, it can be stated that an equal number of boys (13.6%) and girls (13.6%) have normal scapular posture. A large number of boys and girls are assigned grade 1 (69.4%), while 3.4% are assigned grade 2.

Analysis of the differences between boys and girls in scapular posture shows no statistically significant differences (p=0.743, χ2=0.594).

Table 10. Numerical and percentage results of scapular posture analysis by gender

SHOULDER BLADES POSTURE		BOYS	GIRLS	TOTAL
0 = no deviation	N	24	24	48
	%	13.6%	13.6%	27.2%
1 = partial deviation	N	59	64	123
	%	33.3%	36.1%	69.4%
2 = extreme deviation	N	2	4	6
	%	1.1%	2.3%	3.4%
Total	**N**	**85**	**92**	**177**
	%	**48.0%**	**52.0%**	**100%**
χ^2= 0.594 p= 0.743				

The data in Table 11 shows that slightly over half of the participants (58.6%) do not have deviations of the spinal column in the frontal plane. Minor deviations of the spinal column in the frontal plane are present in 29 boys (16.4%) and 46 girls (26%). None of the participants have significant deviations of the spinal column in the frontal plane.

Analysis of the differences between boys and girls in spinal column deviations in the frontal plane reveals a statistically significant difference (p=0.033, χ2=4.564). By comparing the quantitative indicators in Table 11, it can be observed that the significant difference stems from better results of boys compared to girls.

Table 11. Numerical and percentage results of analysis of spinal column deviations in the frontal plane by gender

SPINE POSTURE		BOYS	GIRLS	TOTAL
0 = no deviation	N	56	46	102
	%	31.6%	26%	57.6%
1 = partial deviation	N	29	46	75
	%	16.4%	26%	42.4%
2 = extreme deviation	N	0	0	0
	%	0.0%	0.0%	0.0%
Total	**N**	**85**	**92**	**177**
	%	**48.0%**	**52.0%**	**100%**
χ^2= 4.564 p= 0.033*				

Normal abdominal posture is present in 30.5% of boys and 31.7% of girls. Deviation from normal abdominal posture, which falls under the functional stage of postural disorders, is present in 16.9% of boys and 20.3% of girls.

Based on the results in Table 12, it can be concluded that there is no statistically significant difference in abdominal posture between boys and girls (p=0.520).

Table 12. Numerical and percentage results of analysis of abdominal posture by gender

STOMACH POSTURE		BOYS	GIRLS	TOTAL
0 = no deviation	N	54	56	110
	%	30.5%	31.7%	62.2%
1 = partial deviation	N	30	36	66
	%	16.9%	20.3%	37.2%
2 = extreme deviation	N	1	0	1
	%	0.6%	0%	0.6%
Total	**N**	**85**	**92**	**177**
	%	**48.0%**	**52.0%**	**100%**
χ^2= 1.307 p= 0.520				

The results of the leg posture analysis (Table 13) indicate that there are no statistically significant differences between boys and girls (χ2=0.417, p=0.519). Normal leg posture is present in 53.1% (94) of participants, with a similar number of boys (42) and girls (41) showing minor deviations from normal leg posture.

Normal foot arch is observed in 67 participants, including 28 (15.8%) boys and 39 (20%) girls. Less deviation from normal foot status is seen in slightly less than half of the participants (49.2%), while a larger deviation is present in 13% (7.9% male participants and 5.1% female participants).

The results in Table 14 indicate that there is no statistically significant difference in foot arch between genders (p=0.268).

Table 13. Numerical and percentage results of the leg posture analysis by gender

LEG POSTURE		BOYS	GIRLS	TOTAL
0 = no deviation	N	43	51	94
	%	24.3%	28.8%	53.1%
1 = partial deviation	N	42	41	83
	%	23.7%	23.2%	46.9%
2 = extreme deviation	N	0	0	0
	%	0.0%	0.0%	0.0%
Total	**N**	**85**	**92**	**177**
	%	**48.0%**	**52.0%**	**100%**
χ^2= 0.417 p= 0.519				

Table 14. Numerical and percentage results of the feet posture analysis by gender

FEET POSTURE		BOYS	GIRLS	TOTAL
0 = no deviation	N	28	39	67
	%	15.8%	22.0%	37.8%
1 = partial deviation	N	43	44	87
	%	24.3%	24.9%	49.2%
2 = extreme deviation	N	14	9	23
	%	7.9%	5.1%	13.0%
Total	**N**	**85**	**92**	**177**
	%	**48.0%**	**52.0%**	**100%**
$\chi^2 = 2.632$ $p = 0.268$				

Discussion

Based on the results of the overall sample's nutritional status, it can be concluded that one-third of the children (30.6%) from the total sample have a problem with excessive body weight (11.9% - overweight, 18.7% - obesity). These results are consistent with the study conducted by Kisić-Tepavčević and colleagues (2008). Among all the participants of the study, 15.2% of children were overweight, while 15.5% were obese.

The results of the nutritional status in relation to gender indicate that a larger number of female participants have issues with overweight and obesity compared to male participants. These results can be attributed to the higher physical activity levels of boys in this age group.

The assessment of the overall sample's postural status according to Napoleon Volanski reveals that a very small percentage of children have excellent body posture (1.7%), while 115 participants (65%) have very good body posture, and 59 participants (33.3%) have good body posture. The measurement results indicate that even 169 out of 177 participants (95.5%), included in the study, have two or more deformities. Based on the results of the postural status in relation to gender, it can be said that girls have better postural status compared to boys.

Regarding the results of the correlation between nutritional status and postural status, there is no statistically significant correlation (p=0.115) between these two parameters. Similar results were obtained by Da Silva and colleagues (2011) in their study aimed at determining differences in postural status between normally nourished

and obese children. The results showed no statistically significant differences in postural status in relation to nutritional status.

Individually examined, a statistically significant correlation is only observed between nutritional status and the postural status of the feet (p=0.036). These results are consistent with the findings of similar studies conducted in Poland and Iran at a similar age (Jankowicz-Szymanska & Mikolajczyk, 2016; Sadeghi-Demneh et al., 2016; Shapouri et al., 2019). There are numerous factors contributing to the occurrence of flat feet, but most authors cite overweight and obesity as one of the factors increasing the frequency of this deformity (Živković et al., 2018; Kapo et al., 2020).

The analysis of differences in the status of individual body segments of the participants in relation to gender reveals that in most segments (head posture, shoulder posture, chest development, scapular posture, abdominal posture, leg shape, and foot arch), there is no statistically significant difference. Considering that these are children with relatively similar lifestyles both in kindergarten and outside of it, this result is expected.

A statistically significant difference is only observed in the deviation of the spinal column in the frontal plane (p=0.033, $\chi 2$=4.564) in favor of boys (16.4%) compared to girls (26%). This difference is challenging to explain, but it may be attributed to insufficient muscular development in girls compared to boys. The greater muscular development in boys may indicate their higher physical engagement, particularly in free activities, at this age.

Although there are no statistically significant differences in terms of gender dimorphism, the quantitative results of other body segments should not be overlooked. A large number of children have deviations from normal body posture (functional stage), which represents a potential hazard for the development of so-called structural changes, which are permanent and significantly jeopardize normal growth, development, and functioning of the organism.

The results of many studies (Sabo, 2006a; Đorđić, 2007; Obradović & Milošević, 2008; Pavlović, 2012; Romanov et al. 2014) demonstrate a high prevalence of postural disorders in the foot status among preschool-aged children. These results are in line with the findings of this study, as a large number of children have minor (49.2%) or major (13%) deviations from normal foot arch. This data emphasizes the need to focus the most attention on this postural disorder. Timely diagnosis of flat foot changes is a priority task in order to take appropriate measures and prevent other postural disorders that arise as a consequence of flat feet.

Conclusion

The study included 177 participants from preschool institutions, specifically "Čika Jova Zmaj" kindergarten, with 85 male participants and 92 female participants. The aim of the research was to determine the postural status, degree of nourishment, and their relationship, as well as to identify differences in postural status based on gender dimorphism.

The results showed that there is no statistically significant correlation between the degree of nourishment and postural status in pre-school-aged children. These findings align with a previous study on the association between the degree of nourishment and the frequency of postural disorders of the spinal column in 2018 (Cvetković & Cvetković, 2018). Additionally, there is no statistically significant difference in postural status between participants based on gender dimorphism. In other words, it could be concluded that the degree of nourishment is not a key factor in the development of postural disorders. However, normal nourishment is a prerequisite for proper growth, development, and overall functioning of the organism. The relatively similar lifestyle and uniform growth and development of preschool children contributed to the absence of differences in postural status based on gender affiliation.

The results of this research indicate that a significant number of children have issues with postural disorders and excessive nourishment. These data suggest that both educators and parents have a responsibility to guide children in maintaining proper body posture during sitting, walking, and physical activities. Proper and systematic exercise is essential for preserving and improving children's health (Bićanin et al., 2017), both during their time in preschool institutions and in their free time (Ćirić et al., 2015). Controlled and appropriately dosed physical activity can prevent the occurrence of excessive nourishment (Epstein et al., 1998; Mo-suwan et al., 1998; Eliakim et al., 2007; Ling et al., 2016; Janicke et al., 2021) and postural disorders, as well as correct existing disorders (Protić-Gava, 2014; Milić et al., 2021; Calcaterra et al., 2022). Constant monitoring and analysis of relevant parameters, including postural status, are crucial for designing physical activity programs in preschool institutions based on accurate data (Maksimović & Lertua, 2018). Establishing habits of healthy eating and physical activity greatly depends on the approach of educators (Čvrljak & Međimorec, 2021).

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